Policy, Research, and External Affairs

WORKING PAPERS

International Trade

International Economics Department
The World Bank
February 1991
WPS 596

The Mexican Sugar Industry

Problems and Prospects

Brent Borrell

The economic costs of the extensive government regulation of the Mexican sugar industry are quantified and policy changes are suggested.

Policy, Research, and External Affairs

WORKING PAPERS

International Trade

WPS 596

This paper — a product of the International Trade Division, International Economics Department — is part of a larger effort in PRE to understand the implications for world commodity markets of changes in developing countries' trade policies and to assist developing countries in designing good trade and industry policies. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Pauline Kokila, room S7-040, extension 33716 (60 pages).

The Mexican sugar industry has been subject to extensive government controls over land ownership, cultivation, harvesting, milling, marketing, distribution, and pricing. The many objectives of these interventions include protecting producers and consumers from world price variability, ensuring self-sufficiency, guaranteeing employment and social welfare, providing cheap milling services, and protecting domestic soft drink manufacturers.

Borrell's calculations show that although the interventions have helped stabilize industry returns to some degree, the estimated effective rate of assistance points to a high degree of resource distortion. In years when world prices were low, such as in 1985-88, the effective rate of assistance is estimated in the range of 70-390 percent.

To analyze the impact of changes in Mexican sugar policies, Borrell constructed an econometric model of the Mexican sugar industry. This was linked to a global model of the world sugar industry. Stochastic simulations projecting the Mexican sugar industry under these policies show consumption increasing faster than production and Mexico increasing its sugar imports. It appears unlikely that under such policies Mexico would return to being an exporter of sugar.

In simulations of a sugar industry operating under essentially free trade conditions, Mexico becomes a significant sugar exporter. Production, trade, and stocks are more variable, and consumption growth is curtailed. But welfare in the economy as a whole would be increased substantially. The main beneficiaries would be sugar producers, and the losers consumers — but the loss to consumers would average less than US$3.20 per person per year.

The Mexican Sugar Industry
Problems and Prospects

by
Brent Borrell

Table of Contents

I. INTRODUCTION*

1. The Mexican sugar industry operates under strict government controls. The sugar parastatal, AZUCAR, and other state agencies govern virtually all aspects of pricing and, until recently, AZUCAR controlled virtually all aspects of marketing. State agencies also affect the cultivation and milling of cane and influence the operations of the sweetener-using sector. Market forces appear to play only a minor role in the allocation of resources within the industry and between the industry and the rest of the economy. On theoretical grounds, and based on empirical evidence from other countries, there is a strong prima facie case for believing that the economic performance of the industry is highly constrained as a result of the interventions and that these impose significant costs on the wider economy.

2. The purpose of this study is to make transparent the main economic effects of existing sugar policies. Three broad measures are used to estimate the resource misallocation effects of intervention: the nominal rate of protection, the effective rate of assistance and the net subsidy equivalent. Theoretical arguments are also used to demonstrate other potential inefficiencies in resource use. To estimate the effects of efficiency-improving policies, an economic model of Mexican production, demand, stock

---

* Brent Borrell completed this study when he was employed as a long-term consultant with the International Commodity Markets Division; at the time he was on leave from the Australian Bureau of Agricultural and Resource Economics. Presently, Brent is Chief Market Economist with The Centre for International Economics in Canberra, Australia.

demand and cane-pricing arrangements is constructed. This model is linked to a model of the world sugar market to evaluate the trade and other economic opportunities which should arise from policy reforms.

3. While the methods used to evaluate the current and potential performance of the industry have shortcomings, taken together they provide a broad indication of the costs and benefits of the different policies. Broad policy recommendations are made on the basis of the analytical results.

II. BACKGROUND

The Structure of the Industry

4. Mexico is a large producer and consumer of sugar in world terms but has switched from being a significant exporter to an importer during recent years; presently it is roughly self-sufficient in sugar. For the 20-year period to the mid-seventies, Mexico exported between 20% and 40% of its domestic production (see Table 1). Despite strong growth in sugar consumption, export performance was largely maintained due to reasonably steady advances in production. However, during the oil boom years from 1975 to 1982, production stagnated. Consumption, meanwhile, continued to increase strongly. From 1977 to 1986, Mexico was mostly a net importer of sugar. Only recently has Mexico returned to the world market as an exporter.

5. Production growth resumed after 1982, following policy changes (the 'canero decree of 1979) which were intended to maintain real cane prices in the face of spiraling inflation. In 1987 and 1988, sizable quantities of sugar were exported, albeit due to some extent to a rundown in stocks. For 1989, net exports are estimated to be small and for 1990 imports will likely be necessary to meet the growth in consumption and a shortfall in production.

(i) Production

6. Production is widely dispersed throughout 9 main geographical regions and 14 states (see Table 2). There are 70 sugar mills employing about 40,000

Table 1: Supply-Demand Balance Sheet for Mexican Sugar

	Production	Consumption	Net Exports	End-Year Stocks	Exports/ Production
	('000 tons)				
1960	1,530	1,121	462	404	0.30
1961	1,487	1,156	586	149	0.39
1962	1,531	1,249	365	66	0.23
1963	1,735	1,312	393	96	0.22
1964	1,933	1,424	491	114	0.25
1965	2,107	1,478	555	201	0.26
1966	2,266	1,555	513	399	0.22
1967	2,412	1,650	572	589	0.23
1968	2,338	1,767	676	482	0.28
1969	2,564	1,875	625	554	0.24
1970	2,402	1,992	612	351	0.25
1971	2,489	1,920	551	369	0.22
1972	2,587	2,075	598	282	0.23
1973	2,810	2.298	586	207	0.20
1974	2,838	2,344	496	206	0.17
1975	2,636	2,526	217	100	0.08
1976	2,710	2,675	13	121	0
1977	2,790	2,677	0	234	0
1978	3,131	2,934	74	363	0.02
1979	3,095	3,059	30	506	0
1980	2,457	3,152	-760	650	-0.30
1981	2,642	3,261	-673	705	-0.25
1982	2,739	3,514	-522	452	-0.19
1983	3,076	3,241	-819	1,106	-0.26
1984	3,308	3,343	-273	1,349	-0.08
1985	3,492	3,547	66	1,227	0.01
1986	4,068	3,451	219	1,625	0.05
1987	4,060	3,657	518	1,510	0.12
1988	3,908	4,070	1,014	334	0.25

Source: International Sugar Organization, London.

Table 2: Mexican Sugar Production, by Region and State

Region	State	1985 Sugar Production (Base estandar, tons) Private Mills	Public Mills
Alto Veracruz	Veracruz Oaxaca	326,214	418,516
Bajo Veracruz	Veracruz		422,014
Balsas	Michoacan		143,655
Centro	Morelos Puebla		280,179
Huastecas	San Luis Potosi Veracruz Tamaulipas	65,907	358,324
Noroeste	Sinaloa Nayarit	46,822	312,593
Occidente	Jalisco Colima	107,837	401,402
Pacifico Sur	Oaxaca Chiapas		144,388
Sureste	Tabasco Quintana Roo	39,611	158,464

Source: Latin America & Caribbean Country Department II, Agriculture Operations Division, World Bank.

workers and around 130,000 cane suppliers and 90,000 cane cutters. Average sugar production per mill is around 50,000 tons per year, which is roughly equivalent to the average in Cuba but only about one-half the Brazilian average. Cane production is predominantly small-scale. The average area of cane harvested per supplier is 4.3 hectares. Most cane is harvested by hand, compared to Cuba and Brazil, where over one-half of the cane is mechanically harvested. About 40% of cane area is irrigated. Cane is usually grown in an eight-year cycle and is not grown in rotation with other crops. Other crops could be grown on cane lands; the two most likely are maize and beans.

7. Mills generally produce one or two of three grades of sugar: raw, estandar (mill white) and refined. About 16% of sugar output is in raw form, a little less than 35% is refined and the remainder (about 50%) is estandar. By-products include molasses, bagasse and a small amount of alcohol. About 25% of the bagasse (the cane fiber) is used as pulp in paper making (paper sales make up only a minor proportion of mill revenues). The remainder is burned as fuel in the mills.

(ii) Consumption

8. Over the past decade the annual growth in consumption has averaged a little over 3%. Mostly this reflects Mexico's strong population growth; but relatively strong growth in disposable incomes during the late 1970s and early 1980s also stimulated growth. By international standards, per capita consumption is high at around 40 kg. About 50% of sugar consumption is in the form of processed foods with the remainder being consumed directly. In 1988,

56% of sugar purchased by the food-processing sector was used in soft drinks. Alternative sweeteners hold a very small share of the Mexican sweetener market.

Government Intervention in the Sugar Industry

9. Government intervention is pervasive. It almost completely eliminates the normal workings of commercial markets in the allocation of resources.

- o Legal restrictions on the sale and renting of land largely influence who can grow cane and greatly influence the scale of operation as well as the methods of production.
- o Regulations governing the pricing and delivery terms for cane establish the incentives which affect the quality of cane, the proportion of sugar and molasses produced from the cane, the technology used in mills, the narvesting and milling season length, the utilization of mills, the cane ratooning pattern (i.e., the number of years the cane plant is harvested before being replanted), the scheduling of harvesting and mill delivery, and many cultivation practices.
- o Government ownership of many of the mills and centralized control of milling operations greatly affect their output, technology, investment, location, size and level of employment.
- o The monopoly acquisition and marketing powers of the sugar parastatal "AZUCAR" mean that patterns of storage, distribution, handling, exporting and importing are centrally

controlled--though recently changes have been implemented which reduce AZUCAR's monopoly powers.

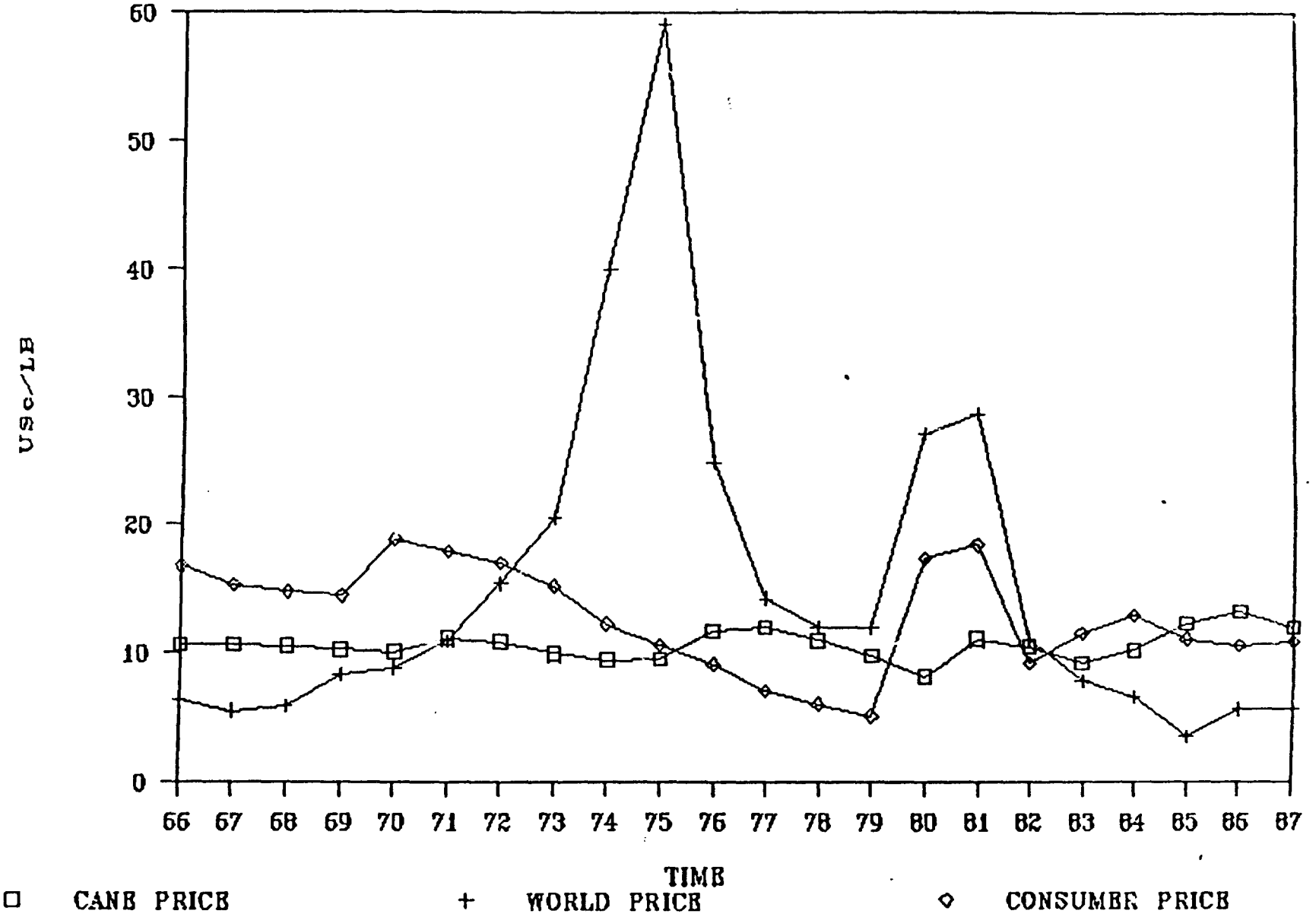
- o Price fixing, price discrimination and trade barriers determine the volume and pattern of production, consumption, trade and stocks, as well as the availability and range of sugar products.

10. The objectives of Mexican sugar policies are not explicitly intended to circumvent the workings of commercial markets nor to impose a system of (virtual) central planning on the industry. Intervention has a very long history. It was introduced to protect the industry from the volatility of world prices as early as 1856 and maybe before then. At that time prices were fixed and imports were controlled. Current policies are the result of a complex series of political and economic responses to problems and unintended consequences of the initial controls; rather than a deliberate, internally-consistent policy. For instance, fixed consumer and producer prices (introduced with the objective of protecting both groups) created an unintended cost-price squeeze which left many mills insolvent. Government buy outs and ownership of mills were the result even though there was not a deliberate policy of nationalization.

11. The accumulation of ad hoc responses left in its wake a wide variety of implicit objectives rather than a prioritized set of consistent goals. Over the last two decades the main purposes of intervention appear to have been:

- To protect the cane-growing sector during intermittent periods of very low world prices and to tax it heavily during short periods of extremely high world prices (see Figure 1).
- To provide a level of social welfare to cane suppliers and mill workers in excess of that generally available to other rural groups.
- To retain the small-scale cane production system to maintain rural employment.
- To ensure a continuing supply of cheap milling services to the cane-growing sector and to expand employment in mills, irrespective of the implicit tax on private sector mills in general and the direct budgetary costs of subsidizing public mills.
- To shield consumers from variability in world prices, providing very high subsidies at times and extracting relatively small taxes at others (see Figure 1).
- To protect domestically-owned soft drink manufacturers from foreign-owned competition through discriminatory pricing.
- To maintain a high degree of self-sufficiency in sugar production, and to encourage production through the provision of subsidized inputs.

Figure 1: MEXICAN CANE AND DOMESTIC SUGAR PRICES AND WORLD SUGAR PRICES



III. THE ECONOMIC EFFECTS OF INTERVENTION

12. The influence of some forms of government intervention are reasonably direct and are quantifiable in terms of their effects on industry returns. Examples include the domestic sugar pricing arrangements and the subsidies paid directly to the industry. Other forms of intervention create indirect effects by modifying the production or marketing environment. Such intervention may cause costs of production and marketing to be higher than otherwise and the extent to which they distort costs is not easily quantified. Examples of such interventions include the cane payment arrangements and the restrictions on the sale and renting of land. While the net effect of intervention is difficult to determine, it would seem that Mexico holds some comparative advantage in the production of sugar. The high degree of regulation, however, raises many questions about the appropriate size of the industry and about its efficiency in resource use.

The Static Costs of Existing Price-Fixing Arrangements

13. Some of the economic costs of the Mexican price fixing arrangements can be illustrated through the use of a static partial equilibrium analysis, such as is represented in Figure 2. In Figure 2A, the situation of Mexican prices being initially above world prices is depicted, such as was the case between 1985 and 1988. In Figure 2B the opposite initial situation is depicted. In both initial situations, WP is the world price, PP is the producer price, and CP is the consumer price which is set at a discount to PP.

Figure 2: PRICE AND WELFARE EFFECTS GIVEN CHANGES IN MEXICAN SUGAR POLICIES

Figure 2A

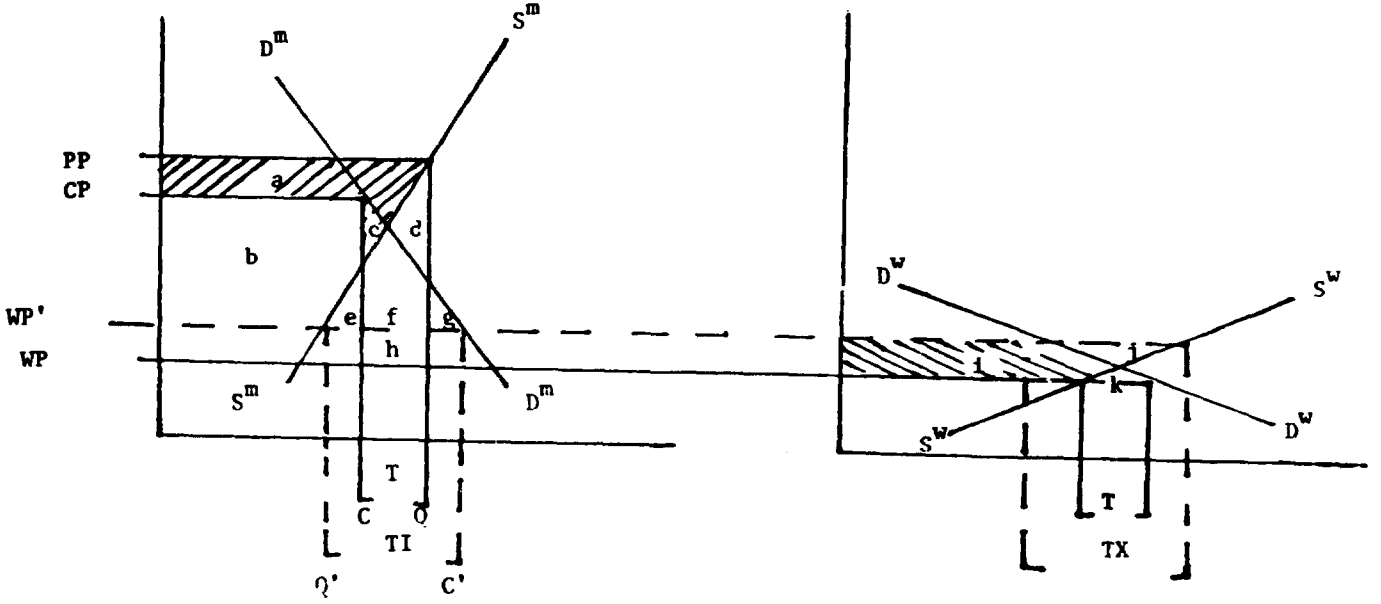
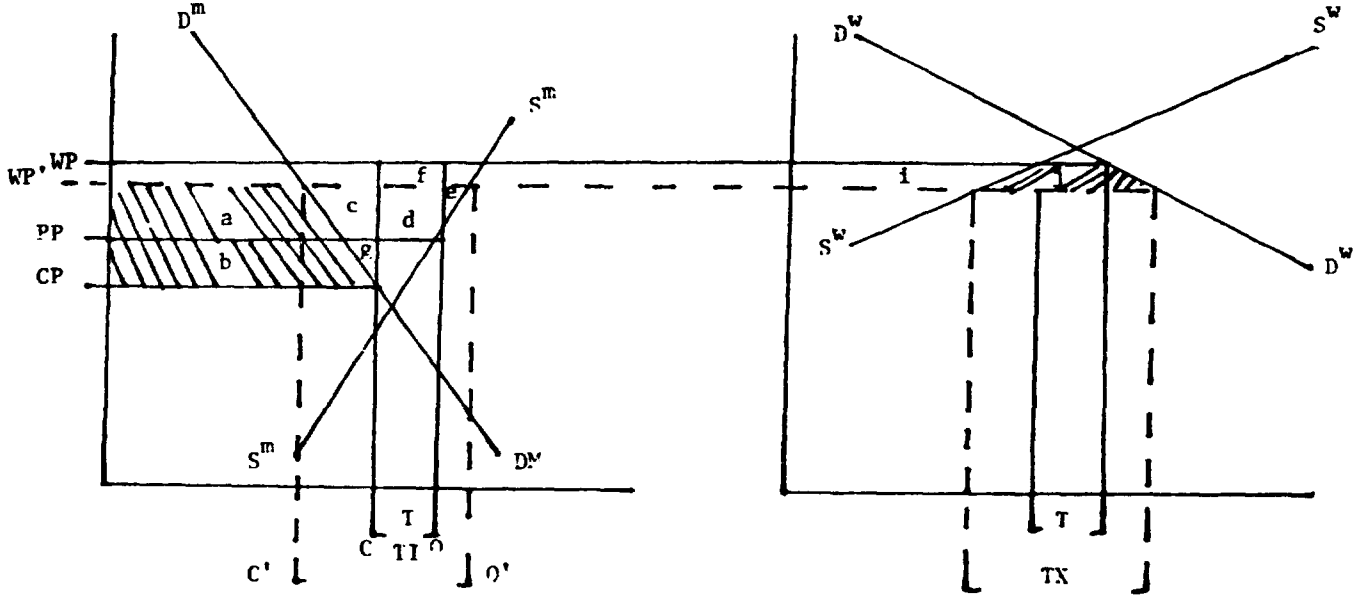


Figure 2B



Mexican producers manufacture Q, and AZUCAR exports T (the rest-of-the-world imports T). On domestic sales, the government must pay the difference between PP and CP; in Figure 2A it also must pay the difference between PP and WP; while in Figure 2B it earns a rent (WP-PP).

14. The free trade case is also depicted in Figures 2A and 2B. In these cases the world price replaces PP and CP as the ruling Mexican sugar price. Output contracts from Q to Q' and C expand to C' in Figure 2A. Trade changes from T to TI--from subsidized exports to free market imports. In Figure 2B, output expands to Q' and consumption contracts to C', thus allowing for an expansion in exports--T to TX. Small changes in world price are shown to occur in both figures due to changes in world trade, (WP to WP').

15. In both Figures 2A and 2B, Mexican welfare is greater in the case of free trade than under the current pricing arrangements. 1/ The costs and benefits of the present policies to the various parties are represented in Figures 2A and 2B as follows:

- loss in consumer surplus: (b + c + e + f + g)
- gain in producer rents: (a + b + c)
- loss in Mexican government revenue: (a + c + d + f + h)
- net cost to Mexico: (d + e + 2f + g + h)
- gain to consumers in the rest of the world: (i + k)
- loss to producers in the rest of the world: (i + j)
- net loss to the rest of the world: (j - k)

1/ The measures on welfare change used are producer rent and consumer surplus (see Mishan, 1968, and Willig, 1976).

16. In Figure 2B the costs and benefits of the present policies are as follows:

- gain in consumer surplus: (a + b)
- loss in producer rents: (a + c + d + e)
- loss in Mexican government revenue: (b + g - d - f)
- net cost to Mexico: (c + e + g - f)
- loss to consumers in the rest of the world: (i + j)
- gain to producers in the rest of the world: (i)
- net loss to the rest of the world: (j)

The Effective Level of Assistance

17. The nominal rate of assistance (NRA), the effective rate of assistance (ERA), and the net subsidy equivalent (NSE) are three measures used to make a broad assessment of the distortionary influence of intervention on an industry. Of the measures, the ERA is the most comprehensive. It takes account of the main direct effects of intervention on both input and output prices, and provides an indication of the net assistance to the industry's value adding activities. To the extent that the assistance enables an industry to command and use more resources than otherwise, the ERA indicates the inefficiencies arising from the misallocation of resources in production. Estimates of the three measures are given in Table 3.

18. In recent years the ERA has mostly been large and positive. This has arisen largely because world prices were very low during this period and well

Table 3: Effective Rate of Assistance to the Mexican Sugar Industry

em	Unit	1989	1988	1987	1986	1985
lue of Output	PESOm	2,732,000	2,732,000	2,732,000	2,732,000	2,732,000
SS Total Inputs						
o materials in milling	PESOm	171,500	171,500	171,500	171,500	171,500
o depreciation in milling	PESOm	210,000	210,000	210,000	210,000	210,000
o materials and depreciation in growing	PESOm	343,000	343,000	343,000	343,000	343,000
o materials in marketing	PESOm	129,500	129,500	129,500	129,500	129,500
Value added	PESOm	2,075,764	2,075,764	2,075,764	2,075,764	2,075,764
PLUS Assistance to Value Adding Factors						
o sugar sales subsidy	PESOm	100,000	100,000	100,000	100,000	100,000
o mill loss subsidy	PESOm	285,000	285,000	285,000	285,000	285,000
o AZUCAR admin. cost sub	PESOm	88,000	88,000	88,000	88,000	88,000
o storage cost subsidy	PESOm	450,000	450,000	450,000	450,000	450,000
Assisted Value Added	PESOm	2,998,764	2,998,764	2,998,764	2,998,764	2,998,764
LESS Assistance to Outputs						
o domestic pricing	PESOm	-740,245	31,365	656,640	802,975	1,172,890
LESS Assistance to Inputs						
o fertilizer subsidy	PESOm	92,635	92,635	92,635	92,635	92,635
o fuel subsidy	PESOm	200,000	200,000	200,000	200,000	200,000
LESS Assistance to Value Adding Factors	PESOm	923,000	923,000	923,000	923,000	923,000
ıassisted Value Added	PESOm	2,523,374	1,751,764	1,126,489	980,154	610,239
Net Subsidy Equivalent	PESOm	475,390	1,247,000	1,872,275	2,018,610	2,388,525
Effective Rate Assistance	%	18.8394	71.1853	166.204	205.948	391.408
Nominal Rate Assistance	%	-21.318	1.16139	31.6398	41.6259	75.2281

Source: AZUCAR

Notes: (a) Data for 1989 have been used to calculate assisted value added in all years, as assisted value added information for 1988 and earlier are not available--this probably does not change much from year to year.

(b) Assistance to output has been estimated for all years--this can change greatly from year to year as the world price changes.

below the fixed prices on the domestic market. As a result the nominal rate of assistance was very high. The rise of world prices in 1989 caused the NRA and the ERA to decline substantially. If prices continue to rise (above about US¢15/lb) it is likely that the ERA will become negative. The world market is notoriously volatile and cyclical. Every six to nine years the world price has boomed and been sustained well above the 15¢/lb mark for periods of two to three years. Although data are not available to make reliable estimates of the ERA for earlier periods, it appears (see Figure 1 which gives an indication of the nominal rate of protection which is similar to the nominal rate of assistance) that the ERA was probably large and negative in 1963-64, again in 1973-76, and also in 1980-81. It is also likely that the ERA was probably large and positive in the intervening periods, such as that between 1985 and 1988.

19. It would appear that the main influence of intervention has been to inject some degree of stability into industry returns. Nonetheless, whether the ERA is positive or negative, that it is large indicates intervention has potentially distorted resource use to a very high degree. Such distortions can impose heavy costs on the industry and on the wider economy.

20. For example, as a result of intervention, production, consumption and trade are distorted through time such that optimal adjustments to changing world market opportunities are not made. Further, deadweight losses are imposed on the wider economy through the raising of tax revenues to provide contingent assistance. While the high degree of regulation, which has stemmed from the granting of assistance, may protect some producers or consumers from

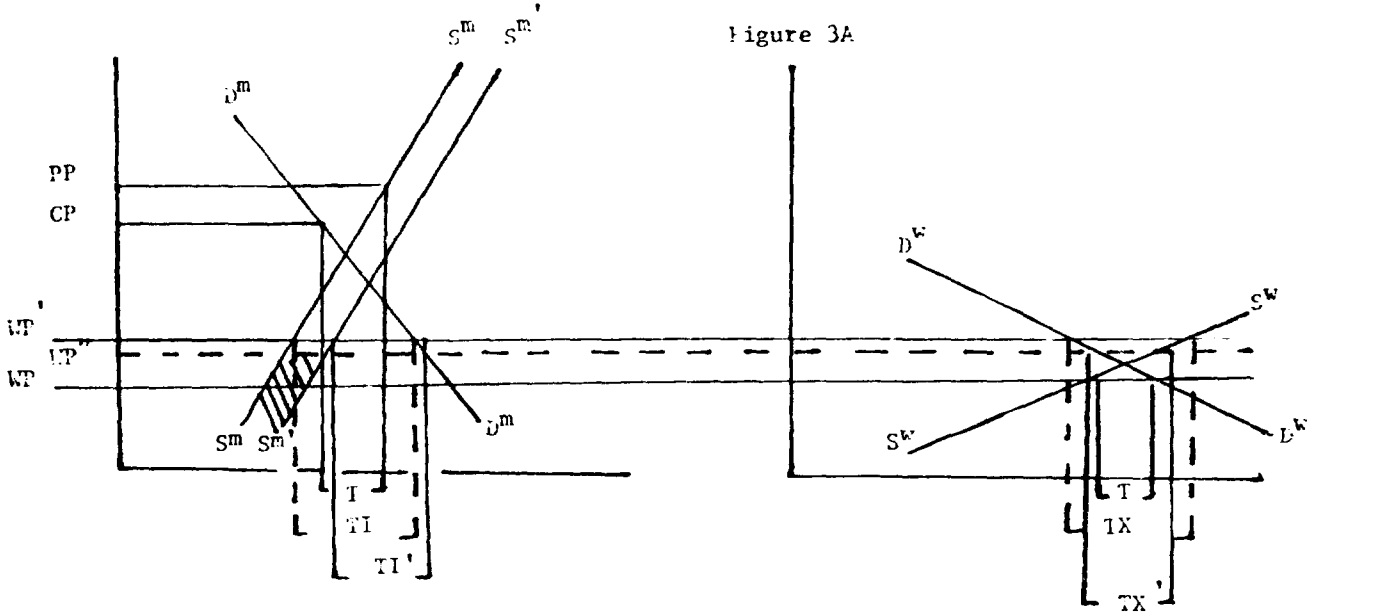
changing market conditions, it penalizes others who may be made to bear higher costs or who are prevented from pursuing profitable opportunities. Therefore, instability of the world market is, to some extent, swapped for the vagaries associated with the political decision-making processes. Thus, any gains in terms of reduced uncertainty arising as a result of intervention are not clear-cut. Uncertainty has probably increased since Mexico entered its period of high inflation after the initial oil boom in the mid-seventies. Since then real returns have been heavily influenced by political decisions to adjust nominally-fixed prices, milling subsidies and other instruments. These have not been adjusted regularly nor in a predictable fashion.

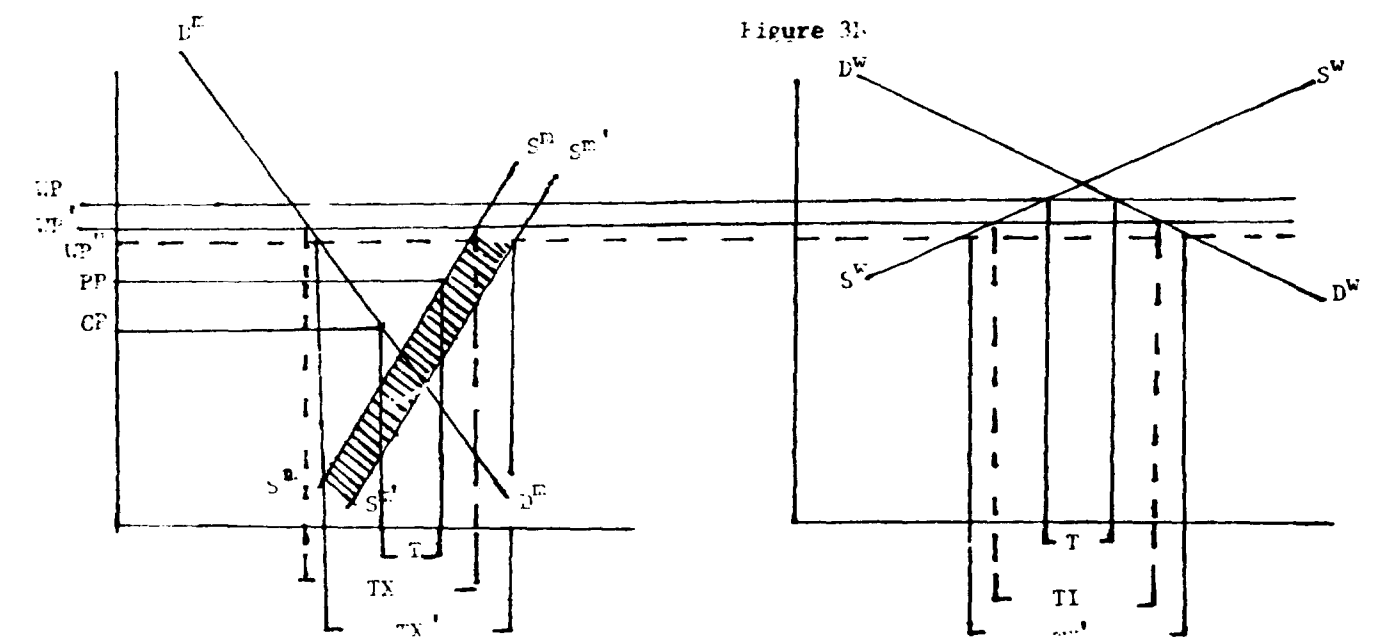
The Effects of Intervention on Industry Costs

21. The nature of the economic costs of intervention to the sugar industry can be illustrated by reference to the same static partial equilibrium analysis presented in Figure 2. Removal of interventions which allow industry costs to fall can be represented as a rightwards shift in the supply curve. In Figure 3, the effects of such a shift from the situations depicted in Figure 2 are demonstrated. In all situations production would expand and producer rents would increase by the shaded areas, adding to Mexican welfare.

22. No aggregate measure of the extent of the cost burden is available. However, AZUCAR (1989) demonstrates that a number of realistic changes in growing, milling and marketing could lower total costs of production by about 20% (these are discussed in general below). The types of changes indicated

Figure 3: PRICE AND WELFARE EFFECTS OF A SHIFT IN THE SUPPLY CURVE





were chosen for illustrative purposes only and do not purport to represent optimal changes. Cost reductions in excess of 20% may therefore be attainable over the longer term.

Overall Assessment of Economic Costs of Existing Policies

23. It would take considerable data and detailed analysis to estimate the net effects of intervention on industry costs. Nevertheless, from prima facie evidence presented in Appendix 1, it seems reasonable to conclude that intervention presently imposes sizable cost penalties on the industry and may have done so for many years.

24. Legal restrictions on the sale and rental of land, for instance:

a. prevent efficient farmers competing with less efficient farmers for resources;
b. cause more intensive use of expensive non-land inputs;
c. restrict farm amalgamation, restricting the rate of capitalization, mechanization and achievement of economies of scale on-farm;
d. limit the rate at which progressive farmers can introduce higher-yielding varieties of cane and new technology.

25. Regulations governing the pricing and delivery terms for cane distort the incentives for growers and millers to maximize efficiency of the industry as a whole. For example:

a. payment for cane is not based on the sugar content of individual farmers' cane, causing efficient farmers to cross-subsidize inefficient farmers, which reduces output generally, and increases the cost of milling--there are scale effects of milling cane of high sugar content which are not achieved;

b. premiums and discounts on the price of cane through the season are not set, which distorts incentives to adjust season length to its optimum--leading to inefficient use of available milling capacity;

c. mills can pass losses of sugar in milling back to farmers and have incentives to maximize molasses producton instead of optimizing sugar output; therefore, inefficient mill practices can be sustained and industry profit is not maximized;

d. mills cannot change cane prices to adjust cane supplies to levels that allow optimal use of existing capacity.

26. Government ownership of milling assets and centralized (bureaucratic) decision-making processes:

a. means that the market for milling capital is not competitive, which probably protects inefficient management, distorts the

location, size and capacity utilization of mills, and restricts financing of new technologies;

b. locks entrepreneurship out of the industry and restricts the adoption of modern management ideas and systems;

c. lacks flexibility to solve practical problems quickly;

d. places political constraints on the profit function which has lead to overmanning and generous wage settlements.

27. Price fixing and trade barriers, as well as insulating the industry from world trade:

a. protect inefficiencies in marketing

b. differential pricing of sugar causes waste in the sugar-using sector, reducing the amount of sugar available for export

c. consumer protection varies inversely to industry protection adding to the inefficient use of sugar and other sweeteners.

In general, centralized (bureaucratic and political) decision-making processes and isolationist trade policies do not provide for efficient mechanisms for allocating resources, either within the industry or between the industry and the rest of the economy. Also, the costs of intervention have the potential to grow over time. Virtually isolated from the world market, the structure of the industry may well diverge further and further from the economic optimum. Then, too, it should be noted that despite the cost disabilities imposed and the lost opportunities for adjustment, over the long term the industry has managed to grow while receiving on average relatively low rates of assistance. The potential therefore for improving the performance of the

industry and its contribution to the wider economy may be considerable.

Recent Changes to Regulations and Controls

28. On November 15, 1989, the monopoly import and acquisition powers of AZUCAR were removed. The requirement that millers pay a 50% tax to market sugar outside the AZUCAR distribution system has been effectively nullified by the granting of a 100% rebate on any such taxes paid. And in place of import licenses which were previously used to exclude private imports, a 10% ad valorem tariff now stands as the only barrier to free entry. However, controls on prices remain and AZUCAR's monopoly exporting rights are unchanged.

29. Presently, the fixed domestic consumer price is roughly in line with the import parity price of sugar. Under existing policies, controls on price will be difficult to maintain if the world price changes. If it falls, imports would enter the country quite freely and undercut the fixed domestic prices. If it rises, there will be strong pressure for black market sales. The production shortfall in the domestic market in 1990 will cause a rise in import demand. However, imports will be unattractive unless they can be sold through the black market at prices equal to or in excess of the world price. The costs of attempting to maintain price controls may be very large. For example, the policing costs of preventing black market activity are likely to be great. And, although black market activities may help improve allocative efficiency in some ways, efficiency losses through "double handling" are also likely to be large.

IV. PROSPECTS FOR THE MEXICAN SUGAR INDUSTRY UNDER DIFFERENT POLICIES

30. An econometric model of the Mexican sugar market was developed to illustrate the effects of the continuation of existing policies and to analyze alternative policies. The model is documented in Appendix 2. The main features of the model are:

- production, consumption and stock demand are explicitly modeled;
- yield and area are separately modeled;
- trade (net exports) is modeled implicitly as a residual;
- the Mexican market is linked to a world market model (by Wong, Sturgiss and Borrell, 1989) through trade;
- the model includes dynamic linkages of market variables from one year to the next, so that the effects of policy can be observed through successive time periods;
- the world model includes the domestic markets and policies of the four largest importers and four largest exporters, plus a rest-of-the-world sector;
- the world model captures the volatility in the world market.

Illustration of the Effects of a Continuation of Existing Policies to 2004

31. To project the broad direction of the Mexican market under existing policies, stochastic simulations using the linked Mexican-world model were

performed. Stochastic simulations are performed to capture the volatility of the world market. The model was run 60 times over the period 1985 to 2004 with different shocks representing random elements affecting production (such as the weather) being applied in each year and in each simulation. The results presented in Table 4 are the averages of the 60 simulations. For the world price, the averages tend to mask the high level of price variability likely to occur (see the range of prices forecast).

32. Because the results presented are the averages of 60 simulations, they represent the average impact under a wide range of potential market conditions. Therefore, the results should be regarded as illustrative of the potential impact under various market conditions rather than forecast effects based on current market conditions. The forward simulations are performed based on information up until 1985. The simulations therefore do not, for instance, take account of the recent, and mostly unexpected, decline in Mexican production--caused, in part, by frost damage.

33. Also, most exogenous variables are set according to those given in Wong et al. (1989). So, for this and the reasons given above, the price projections given in Table 4 should not be regarded as World Bank forecasts. They do, however, represent the type of price behavior that can generally be expected in the world market.

34. Mexican cane prices, consumer prices, the percentage extraction of sugar, and the stocks-to-production ratio are exogenously determined and are set from 1988 onwards at average levels over the period 1967 to 1987. (Strong

Table 4: Projections of Mexican Sugar Production, Consumption, Trade and World Prices, 1985-2004 (Unchanged Policy Scenario)

Year	Production	Consumption	Net Exports	Year-End Stocks	World Price	World Price Sim. 1 a/	Cane Price
	(Million Tons)				(1984 US¢/lb)		(1980 pesos/ton)
1985	3.45	3.31	0.726	0.76	7.9	6.7	448
1986	3.75	3.44	0.248	0.83	6.6	5.1	483
1987	3.98	3.63	0.394	0.88	9.6	7.4	435
1988	4.29	3.67	0.551	0.94	10.7	12.6	330
1989	4.00	3.80	0.26	0.88	15.1	14.4	350
1990	3.94	3.94	0.016	0.87	15.5	18.6	393
1991	3.98	4.08	-0.108	0.88	12.8	19.7	393
1992	4.01	4.23	-0.223	0.88	15.7	17.5	393
1993	4.25	4.38	-0.185	0.94	26.7	17.9	393
1994	4.63	4.54	-0.001	1.02	24.7	26.8	393
1995	4.70	4.71	-0.029	1.03	15.4	25.5	393
1996	4.77	4.88	-0.128	1.05	12.3	9.7	393
1997	4.88	5.07	-0.209	1.07	13.3	9.8	393
1998	4.98	5.25	-0.292	1.10	15.8	16.4	393
1999	5.09	5.45	-0.382	1.12	16.3	21.0	393
2000	5.19	5.65	-0.481	1.14	15.6	25.5	393
2001	5.07	5.86	-0.761	1.12	20.8	24.2	393
2002	5.40	6.08	-0.753	1.19	23.7	22.6	393
2003	5.50	6.31	-0.83	1.21	19.9	30.6	393
2004	5.60	6.55	-0.964	1.23	17.3	25.4	393
Mean of 1200 observations					15.8		
Coefficient of Variation					0.45		
Range Min-Max of 60 simulations					3.1-50.1		
% of Observations in the Range					8.8-21.8=67		

a/ Simulation 1 was the first of the 60 stochastic simulations and was included to illustrate a more realistic variability of prices than is evident in the averages of all 60 simulations given in the preceding columns.

econometric evidence could not be found to establish significant behavioral equations for these four variables.) The sugar equivalent cane price was assumed to be 60% of the mill door sugar price (40% of the sugar price is fairly representative of the milling margin in other major cane producers: Australia, Brazil, Colombia, Mauritius, South Africa and Thailand, which range from 30% to 50%). A margin of US¢1.7/lb was assumed between the mill door and consumer prices.

35. As argued earlier, there is no direct relationship between cane, mill door and consumer prices, and milling and marketing margins can move in arbitrary ways. Government subsidies can greatly distort such margins. No attempt has been made to account explicitly for such subsidies in the model. Supply is modeled as a function of the cane price only. So explicit determination of the subsidies is inconsequential to the assumed supply response (see Appendix 2). Nonetheless, attempts are made later to account for the welfare effects of such subsidies. For the baseline simulation it was assumed that the number of mills owned by government in 1987 continued unaltered into the future.

36. The most striking feature of Table 4 is the trend towards increased imports which rise to around 1 million tons by 2004. Consumption is projected to continue to grow strongly in line with population growth, and to a lesser extent, income growth. Production meanwhile is shown not to increase as rapidly. Stocks tend to increase in line with general growth in the domestic market. The world price is projected to average US¢15.8/lb over the whole period (which compares with the 38-year average world price up to 1984 of

15.1¢/lb). The range of all stochastically simulated prices (1,200 in total) is large, from 3.1¢/lb to 50.1¢/lb. Two-thirds of the observations lie within the range 8.8¢ to 21.8¢/lb, and the coefficient of variation is high at 0.45 (although it is less than the 38-year historical coefficient of variation of 0.71 which partly reflects structural changes in the market). The first of the 60 individual simulations is shown in column six to give an indication of the typical cyclical variability in price.

37. The projected annualized rate of growth in production is around 2.5%, which is slower than that achieved in the previous three decades. For consumption, the annualized growth rate is around 3.5%, which is a little stronger than for the previous decade. In line with the assumptions about exogenous variables given by Wong et al. for developing countries, annual population and income growth were set at 2.5% and 2%, respectively. To test the sensitivity of the results given in Table 4, the model was run a second time while assuming annual growth in disposable income averaged 1% only. The results are given in Table 5 where it can be seen that the growth in consumption has been trimmed and production is much the same; it is interesting to note a slight reduction in average world price arising from Mexico's reduced import demand.

38. Many uncertainties surround the outlook for Mexican income and sugar industry growth rates. Nonetheless, based on the simulation results it would appear unlikely that Mexico will return to the world market as a significant exporter of sugar, at least while it retains its existing policies. Population and income growth are likely to cause consumption to outstrip

Table 5: Projections of Mexican Sugar Production, Consumption, Trade and World Prices, 1985-2004 (1% Income Growth Scenario)

Year	Production	Consumption	Net Exports	Year-End Stocks	World Price	World Price Sim. 1	Cane Price
	(Million Tons)				(1984 US¢/lb)		(1980 pesos/ton
1985	3.45	3.30	0.74	0.76	7.90	6.90	448
1986	3.75	3.40	0.28	0.83	6.60	5.10	483
1987	3.98	3.58	0.45	0.88	9.50	7.40	435
1988	4.29	3.60	0.63	0.94	10.60	12.50	330
1989	4.00	3.70	0.36	0.88	14.90	14.30	350
1990	3.94	3.81	0.14	0.87	15.30	18.40	393
1991	3.98	3.93	0.04	0.88	12.60	19.40	393
1992	4.01	4.05	-0.04	0.88	15.60	17.30	393
1993	4.25	4.17	0.03	0.94	26.30	17.70	393
1994	4.63	4.30	0.24	1.02	24.40	26.30	393
1995	4.70	4.43	0.25	1.03	15.30	25.10	393
1996	4.77	4.57	0.19	1.05	12.10	9.60	393
1997	4.88	4.71	0.15	1.07	13.00	9.60	393
1998	4.98	4.85	0.11	1.10	15.30	15.90	393
1999	5.09	5.00	-0.21	1.12	15.80	20.30	393
2000	5.19	5.16	0.01	1.14	15.10	24.90	393
2001	5.07	5.31	-0.21	1.12	20.20	23.90	393
2002	5.40	5.48	-0.15	1.19	23.00	22.20	393
2003	5.50	5.65	-0.17	1.21	19.30	29.70	393
2004	5.60	5.82	-0.24	1.23	16.80	24.40	393
Mean of 1200 Observations					15.50		
Coefficient of Variation					0.45		
Range Min-Max of 60 simulations					3.1-49.5		
% of Observations in the Range					8.8-21.3=67		

Source: IECCM, World Bank.

production and it is likely Mexico will increasingly need to rely on imports to satisfy consumption growth.

The Effects of a Change to Free Trade

39. Earlier it was argued that price fixing and isolationist trade policies restrict profitable opportunities to adjust production, consumption and trade. It was also argued that regulations and controls which have been spawned to support interventionist policies impose severe cost burdens on the industry. A scenario was set up to test the trade effects and to estimate the welfare impacts of a change to free trade.

40. To simulate free trade, world prices were transmitted to consumers and producers in place of regulated prices. The baseline assumed that cane growers received 60% of the millers' (f.o.b.) price. Consumers were assumed to pay the world raw price plus 1.7¢/lb for transport, handling and marketing. The 1.7¢/lb margin was set in line with the assumed margin of the baseline simulation, assuming free trade would not alter the efficiency of marketing. Some anecdotal evidence suggests free trade may result in reductions in marketing margins. Apparently, since November 15, 1989, when AZUCAR's monopoly acquisition powers were abolished, the cost of transporting sugar from Veracruz to Mexico City has been halved. Failure to take account of such effects will tend to bias downward the welfare gains from free trade.

41. For the free trade scenario, it was also assumed that the government sold all mills from 1989 onwards and that growers shortened their ratooning

length by two years--thus increasing the average yields of cane. In terms of the earlier discussion, such changes shift the supply curve rightwards. As discussed in the Appendix 2, and in line with earlier discussion, government ownership of mills and ratooning length are important factors affecting cane supply. Changes in these factors with a move to free trade are representative of the types of supply shifts likely to arise from easing of regulations and controls which presently underpin interventionist policies.

42. The results of the free trade scenario are given in Table 6. Compared to Table 5, production, trade and stocks are more variable and consumption is curtailed. Production is much higher with the result that import demand is eliminated and replaced by significant exports. By adding to world supplies, the average world price declines. The effect of these changes on the welfare of producers, consumers, the government and the Mexican economy in general are given in Table 7. In the case of welfare changes in producer rents, account is taken of the increase in growing cost likely to arise from reducing the number of ratoons and increasing the proportion of plant cane in the composition of harvested cane. Costs of growing plant cane are greater than for ratoon cane. From industry data it was estimated that reducing the number of ratoons by two would increase the production costs by about US¢0.5/lb--which must be offset against the gains from the increase in yield.

43. The welfare measures in Table 7 were calculated in the manner discussed in Section III. For computational ease, the welfare effects (producer rents) of the supply shifts were calculated by solving for the equivalent cane price increase needed to induce a supply response equal to

Table 6: Projections of Mexican Sugar Production, Consumption, Trade and World Prices, 1985-2004 (Free Trade Scenario)

Year	Production	Consumption	Net Exports	World Price	Cane Price
	(Million Tons)			(1984 USc/lb)	(1980 Pesos/Ton)
1985	3.42	3.31	0.71	7.62	280
1986	3.61	3.43	0.14	6.45	237
1987	3.66	3.50	0.16	9.72	357
1988	4.05	3.60	0.38	11.22	412
1989	4.61	3.66	0.83	14.48	532
1990	5.47	3.79	1.50	12.39	455
1991	6.11	3.94	2.03	9.37	344
1992	5.83	4.03	1.86	11.90	437
1993	5.83	4.02	1.81	21.94	806
1994	7.23	4.16	2.76	21.24	780
1995	9.03	4.41	4.22	12.52	460
1996	8.73	4.59	4.21	9.28	341
1997	6.92	4.71	2.60	10.29	378
1998	5.72	4.80	1.18	13.31	489
1999	5.79	4.92	0.85	14.46	531
2000	7.12	5.10	1.73	13.50	496
2001	8.01	5.23	2.59	16.88	620
2002	8.60	5.38	3.09	18.38	675
2003	8.90	5.57	3.25	15.55	571
2004	8.80	5.76	3.06	13.75	505
Mean of 1200 Observations				13.60	485.30
Coefficient of Variation				0.44	
Range Min-Max of 60 simulations				3.2-42.6	
% of Observations in the Range				8.0-18.6=67	

Source: IECCM, World Bank

Table 7: Welfare Effects of a Switch to Free Trade and Liberalization of Domestic Controls

Year	Producer Welfare	Consumer Welfare	Government Revenue*	Economic Surplus
	(1984 US$ Millions)			
1985	-199.70	214	179	193.30
1986	-336.79	310	185	158.21
1987	7.66	75	203	285.66
1988	177.36	-11	176	341.86
1989	619.18	-287	162	494.18
1990	531.70	-192	192	531.70
1991	99.65	62	202	363.65
1992	471.74	-161	190	500.74
1993	2,057.74	-1,083	162	1,136.74
1994	2,222.30	-1,012	233	1,443.30
1995	680.46	-170	235	745.46
1996	-35.23	162	239	365.77
1997	184.72	26	244	454.72
1998	809.95	-403	248	654.95
1999	1,097.18	-595	263	765.18
2000	946.52	-425	275	796.52
2001	1,403.71	-664	186	925.71
2002	1,666.20	-760	362	1,286.20
2003	1,294.90	-556	339	1,077.90
2004	1,112.00	-470	333	975.00
Mean	740.56	-314	230.40	656.96
Benefit per $ of transfer to consumers	-2.35	1	-0.73	-2.09

* From elimination of profits and losses of exports and imports and from the elimination of subsidies to mills.

Source: IECCM, World Bank.

that arising from the rightward shift in the supply curve. The welfare effects were then estimated in the fashion shown in Figure 2.

44. The government revenue saved includes both direct subsidies to government-operated mills and indirect subsidies through present pricing arrangements. In recent years these have been sizable, as shown in Table A1.2.Under free trade such subsidies would be eliminated. The subsidies basically represent transfer payments from the government to the milling sector. Producer rents are calculated net of these subsidies. For calculating welfare effects it was assumed that the average rate of indirect subsidy per ton applying in the past decade would continue. The difference in time period reflects the availability of data.

45. For the economy as a whole, welfare is increased substantially in all years with a move to free trade. The main beneficiaries are producers. Consumers, on the other hand, generally pay higher prices and so are net losers. Producer gains arise from higher average prices, from increased production, from timing production increases and decreases in line with the world market price cycle, and from implied reductions in costs given by rightward shifts in the supply curve. Government gains, which in effect are savings to taxpayers, arise from eliminating subsidies on exports. The welfare gains are seen to increase through time because under protectionist policies the structure of the domestic market diverges increasingly from what is optimal under free trade and so the gains from a switch to free trade increase. The benefits have not been discounted to net present value terms.

46. For individual consumers the net cost each year averages less than US$3.20 per person, although in some years the cost may be up to four times this amount. However, due to the very low price elasticity of demand for sugar (see Appendix 2), consumption is only mildly curtailed even at high prices. Therefore, the effect on the sugar-using industries is not likely to be large.

47. For individual producers the annual gains could be substantial. But calculating the average impact is complicated. Substantially more land is estimated to come into production and so it is reasonable to assume new farmers may come into the industry. Others may leave and farms may be amalgamated. Nevertheless, the average annual gains would amount to around US$3,174. Also, assuming no change in the number of mills, annual average gains of around US$4.2 million per mill are simulated. Mill workers and cane cutters may share some of the simulated gains to mills and farmers. Although significantly higher on average, incomes would tend to be more highly variable, in line with world prices. Even the variability in changes in producer rents shown in Table 7 do not fully reflect the possible variability in incomes. Individual simulations of the model show considerably more variability. The variability in world prices is probably the best indicator of potential income variability. Ninety-five percent of simulated prices lie in the range US¢5.1/lb to US¢26.2/lb; 67% lie in the range 8¢ to 18.6¢/lb; the complete range of simulated prices is 3.2¢/lb to 42.6¢/lb.

48. However, in a free market it is unlikely that the full variability in world price would be transmitted back to producers due to the use of futures markets. Other special (long-term contractual) arrangements between traders

and the industry could flourish in a free market. Vertical integration between mills and sugar users may also lead to more stable prices at the producer level. In a free market, producers' demands for risk spreading may spawn the use of a great variety of instruments and arrangements. The type and degree of risk spreading required is likely to vary among producers. The use of a number of different instruments will allow for optimal risk spreading.

49. Often, government-operated risk-spreading schemes have been favored over privately-operated schemes in volatile commodity markets. However, it is not clear that governments have a comparative advantage in providing such services. When governments operate such schemes they are usually designed to apply universally to all producers. In fact, such schemes may be totally unsuitable for many producers. Moreover, because such schemes apply universally, restrictions must be enforced which introduce new regulations and controls. The parameters of the instruments may also become politically determined. Through time, therefore, rent-seeking can alter the nature of the instrument as well as its effects.

The Effects of a Guaranteed Minimum Price Scheme

50. To examine some of the immediate impacts of a government-operated, risk-reduction scheme for producers, a further scenario was simulated. The guaranteed price was assumed to decline in steps of US¢1/lb each year from US¢15/lb in 1990 to zero in 2005. Hence, the scheme is assumed to be transitory, designed to provide a cushion to protect producers for a limited period as they adjust to prices on the world market. It was assumed that

whenever the world price fell below the guaranteed level the government would make up the difference.

51. The average guaranteed price over the scheme's 15-year life is 8¢/lb. Over all 60 simulations the percentage of prices falling below 8¢/lb is around 16%. Averaged out over all years and all simulations, the annual expected payment by government under this scheme would be US$95 million. The average annual expected increase in producer rents would be US$93 million, arising from an average increase in production of 1.5% (or 0.1 million tons) and an expected 5.2% increase in producer prices. In any particular year, payouts to producers of over US$1 billion may need to be made. For this reason, if it is considered to be politically desirable to protect producers for a limited period as they adjust to prices on the world market, direct income support may have considerable advantages over price supports. Direct income support is not open-ended; it provides less distortionary price signals to producers; and it can be targeted to those groups most in need of support.

Discussion of Simulation Results

52. It would appear from the results presented that the main effect of current policy is to subsidize sugar consumption. If the objective of policy is to continue supplying cheap sugar, it appears that the policy will be highly inefficient. For every US$1 transferred to consumers US$2.09 will be lost from the economy (in terms of lost opportunities). It will cost the government an estimated US$0.73 and producers an estimated US$2.35 to provide that support (see Table 7).

V. CONCLUSIONS AND RECOMMENDATIONS

53. Based on the evidence presented in this paper, it appears that the performance of the Mexican sugar industry falls well short of its economic potential. Isolationist trade policies and the plethora of regulatory controls that have evolved over many years to support them, greatly limit individual initiative and opportunity in the industry; they fail to provide efficient mechanisms for allocating resources, either within the industry or between the industry and the rest of the economy.

54. The objectives of the sugar policy are not clear-cut. Policy appears to have evolved over a long period in response to a variety of political and economic pressures. Accumulated ad hoc responses through time mean there is not an explicit set of consistent and prioritized objectives. The main effects of policy appears to be to stabilize prices to cane growers, to deliver health services to cane-growing families, to disguise rural underemployment by creating jobs in sugar mills, and to provide consumers with cheap sugar.

55. Achievement of these objectives appears to occur at very high costs. Despite some benefits accruing to producers, the policy on balance appears to impose a high cost on them. It also imposes high costs on taxpayers and the overall economy. The only net gainers appear to be consumers, but the efficiency of the transfer of support to consumers from producers and taxpayers is very low. It would seem that less costly means of providing the same benefits to consumers could be devised.

56. At minimum, an efficient Mexican sugar policy would need to embody the following:

- more efficient mechanisms for allocating resources;
- individual farmers and millers be given incentives to specialize and pursue geographic, managerial or other production, technological or marketing advantages;
- the world price be recognized as the value (or opportunity cost) of sugar to the Mexican economy--despite the distortions in the world sugar market, the factors that determine sugar's place in the Mexican economy and the comparative advantage of individuals and sectors of the industry should reflect international market realities;
- if it is deemed politically desirable to favor particular groups, support should be provided as much as possible through direct income support rather than via prices which distorts production and consumption decisions.

Suggestions for Policy Reform

a. Increase the mobility of land resources; for example, through competitive contract farming arrangements that encourage good farm managers to expand their influence and allow for larger parcels of land to be jointly farmed.
b. Privatization of mills.
c. Allocation of regulations governing the pricing of cane in tandem with land and mill reforms to allow for negotiation between millers and growers over the price, quantity, quality, and delivery terms of cane.

d. Dismantle remaining barriers to trade and allow world prices to be freely transmitted to domestic cane and sugar markets:

e. AZUCAR's remaining monopoly acquisition, exporting and importing rights should cease, and in line with AZUCAR's other transitional watchdog and agency functions, it should monitor and anticipate demand of growers, mills, domestic users and traders for services which facilitate efficient marketing and help establish stability in the market through the use of commercial instruments--this might, for example, include helping traders tailor specific hedging strategies and services for groups of growers concerned about the inherent instability in the world price.

References

AZUCAR (1989), Bases para el Establecimiento de Nueva Politica en Materia de Fijacion de Precois, Reporte Final: Modulo 4, Reporte para USO Exclusivo del Banco Mundial.

Mishan, R.J. (1968), "What is producer's surplus?" American Economic Review 58(4), 1969-82.

Willig, R.D. (1976), "Consumers surplus without apology," American Economic Review 66(4), 589-97.

Wong, G., R. Sturgiss and B. Borrell (1989), The Economic Consequences of International Sugar Trade Reform, ABARE Discussion Paper 89-7, AGPS, Canberra.

Appendix 1

THE NATURE OF THE PRESENT COST BURDENS

57. Land: Legal restrictions on the sale and renting of land prevent efficient cane farmers from competing with less efficient cane and non-cane farmers for resources. Although illegal, renting land occurs in agriculture. However, farmers are reluctant to grow cane on rented land because cane is a perennial crop. Without a legally binding contract for the eight-year life of the crop, the risks associated with renting land for cane production are high.

58. The restriction may, in effect, lock land out of the industry. Growers with a clear comparative advantage are prevented from expanding either on existing cane land or on land currently used for alternative purposes. Moreover, to increase production, efficient farmers may use more non-land inputs than is optimal. Despite highly diminishing returns, irrigation resources, for instance, may be fully allocated to the farmer's existing parcel of land even though the returns to allocating some of it to new, presently unirrigated areas may be higher. The effect is to restrict production and raise the unit production cost.

59. Total costs of the industry are also higher than otherwise because high-cost techniques of production are sustained and are prevented from being replaced by lower-cost techniques of efficient farmers. Over the longer term, such effects may be magnified because farm amalgamation is restricted. As a result, the rate of capitalization, mechanization and achievement of economies

of scale on farms are restricted. And the rate at which progressive farmers can introduce higher yielding varieties of cane and new technology is limited. Unable to pursue their comparative advantages, progressive entrepreneurial farmers who might otherwise provide important business and commercial leadership, could be lost from the industry.

60. Cane pricing: Regulations governing the pricing and delivery terms for cane distort the incentives facing growers and millers and impede maximization of efficiency in the industry. The basis for payment to growers involves a guaranteed minimum of 83 kg of estandar sugar for each ton of cane delivered, irrespective of the actual sugar content of the cane. Growers collectively receive bonuses if the seasonal mill average exceeds 83 kg of sugar per ton of cane. They receive no penalty if the result falls short of this level and, under certain circumstances, can still receive a bonus. For the basis of payment the mills' maximum permitted loss of sugar in milling is limited to 26.4 kg measured estandar sugar per ton of cane. The growers' sugar content is, therefore, deemed to be the actual yield of sugar per ton of cane minus the minimum of the actual milling loss or 26.4 kg.

61. Because payment for cane is not based on the sugar content from individual farms, there is a classic "free-rider" problem. Growers who supply high-quality cane cross-subsidize those supplying low-quality cane in the event that a bonus is payable. If, because of low-quality cane, less than 83 kg of sugar per ton of cane is produced, mills are forced to subsidize suppliers--although a mill's risk of receiving very low quality cane is limited under collectively negotiated contracts specifying that mills are

obliged only to accept cane of a certain guaranteed minimum standard. The contracts also provide the mills with a wide range of controls which enable them to greatly influence agronomic practices and thereby ensure that certain minimum standards are met. Nonetheless, farmers (and mill managers) do not have any incentive to optimize the sugar content of their cane. As a result, output and productivity are probably sub-optimal.

62. Because growers are not paid on the sugar content of their cane they have little incentive to deliver their cane quickly to the mill after cutting. Once cut, bacteria act to reduce the sugar content of cane. Losses of sugar content increase exponentially as the time between cutting and crushing increases. In Mexico, the average time to deliver cane after cutting is about 90 hours. By comparison, in Colombia it is around 24 hours and in Australia, a country that achieves exceptionally high levels of sugar content, the time is less than eight hours. The sugar content of cane greatly influences the efficiency of milling. The higher the sugar content the lower the unit cost of milling. Failure to optimize the sugar content therefore impairs mill efficiency.

63. Just as mills cannot change cane prices to reward supplies of high-quality cane, they cannot change prices to influence cane suppliers in other ways. Without being able to encourage or discourage the quantity of cane delivered, achieving the optimal use of milling capacity is a major problem. For instance, premiums and discounts on the price of cane throughout the season would allow the mill to adjust the season length to its optimum, but are not used.

64. The sugar content of cane changes throughout the season, reaching a peak in mid-season. To achieve a high sugar content, growers seek as short a season length as possible. However, for the industry as a whole (and for mill areas that could expand cane production or close mills) it should pay to extend the season length in both directions up to the point where the marginal cost of cane and milling equals the marginal revenue from sugar production. For mill areas that cannot expand cane production, more sugar could be extracted by shortening the season length and using surplus intraseason mill capacity.

65. Mills are not penalized for sugar losses up to 24.6 kg per ton of cane, and therefore have no incentive to control such losses. Indeed, they may have incentive to produce more or higher quality by-products (molasses and alcohol) and less sugar than might be optimal for the industry as a whole. Mills do not share revenues from by-products or black market sales with growers and therefore it may pay them to allow the permitted 26.4 kg loss of sugar to be transferred to molasses or alcohol production or to be sold on the black market. Table A1.1 shows that mills, on average, have consistently achieved close to the permitted loss.

66. The incentive for mills to optimize sugar output is also distorted in other ways. The sugar prices paid to growers and mills are set independently by two separate government bodies and can move out of alignment. Although the marginal cost to growers of increased sugar extraction is zero, mills must pay bonuses for cane (based on the prevailing price of cane) as they increase their extraction rate. Because of these differential pricing arrangements it

Table A1.1: Loss of Sugar in Milling

Year	Measured Sucrose Content of Cane %	Sugar Yield Per Ton Cane %	Sugar Loss Per Ton Cane %	Kg
1981	11.28	8.25	3.03	30.3
1982	11.34	8.42	2.92	29.2
1983	11.78	8.89	2.89	28.9
1984	11.53	8.74	2.79	27.9
1985	11.58	9.03	2.55	25.5
1986	11.80	9.14	2.66	26.6

Source: AZUCAR.

would seem that the marginal cost to mills of extracting sugar from cane could move in rather arbitrary ways relative to the marginal revenue from increased sugar production. It is highly unlikely, therefore, that mills face incentives to optimize extraction of sugar.

67. Moreover, because the price of cane is not related to the price of sugar, mills can be caught in a cost-price squeeze. Such a situation forced many mills to sell out to the government during the seventies. Other consequences of the cost-price squeeze have been to force some mills to make black market sales of sugar to ensure their survival; and in the case of many public mills, it has led to a need for continual direct underwriting of mill losses by the government (see Table A1.2).

68. Given the manner in which the cane- and sugar-pricing arrangements can distort milling margins, it is unlikely that mills face incentives to

Table A1.2: Direct and Indirect Subsidies to Mills
(Constant 1989 Dollars)

Year	Direct a/	Indirect b/
1977	na	161
1978	na	191
1979	na	179
1980	na	0
1981	na	0
1982	168	82
1983	81	12
1984	91	0
1985	131	38
1986	116	30
1987	94	0
1988	32	na
1989	92	na

a/ Source: AZUCAR.
b/ Difference between the mill door and the consumer price times production.

optimize investment and capacity utilization. Over the 1987/88 season, an average of 41 days (about 26%) of intraseasonal mill capacity was idle. The season length of mills ranged from as little as 63 days to as high as 224 days and lost time ranged from as little as 8% to as high as 53%. The variability in lost time and season length provide an indication of the scope for altering both factors to enhance efficiency.

69. Excluding the cost of purchasing cane, about 80% of the annual costs of milling are fixed. The marginal cost of milling is therefore only about 20% of the average cost of milling. Better utilization of existing milling capacity, achieved either through increased cane production or through mill closures and other rationalizations, could significantly lower average milling

costs. However, without the ability to easily adjust cane supplies and facing greatly distorted milling margins, millers are restricted in achieving such economies of scale. Economies of scale also relate to the absolute or technical capacity of the mill. Average mill size in Mexico is approximately one-half that of Brazil and is one indicator of the potential to improve milling efficiency.

70. Another indicator of the potential to increase efficiency in milling relates to the scope to introduce new technologies. By comparison with Brazil, South Africa and Australia, Mexican milling technology lags considerably. The number of rollers used at each stage of crushing is fewer and the idea of force feeding cane has not been introduced to any great extent. For this reason the rate of sugar extraction is not as high as in other countries. This is consistent with the incentive structure which fails to reward millers for minimizing sugar losses.

71. Within the cane payment arrangements is the obligation of mills to provide mill suppliers and their families a minimum level of health services. Irrespective of the quantity of cane supplied, suppliers qualify for the same health coverage. The value of this service exceeds that granted to other rural workers. Thus, land owners have a strong incentive to supply at least a small amount of cane irrespective of their comparative advantage in producing cane. This is an additional factor causing mill margins to move in arbitrary ways and encourages the continuation of small-scale farming practices. In the 1987/88 season, 43% of farmers harvested areas smaller than 2 hectares and 69% harvested areas less than 4 hectares.

72. Because the pricing mechanism is not used to coordinate activities between the growing and milling sectors, alternative instruments and arrangements have been devised. Committees made up of grower and miller representatives have been formed to devise programs for growing, cultivation, mechanization, harvesting and delivery. Allocation of resources within mill areas therefore tend to be centralized to a large extent, which limits initiatives of individual farmers.

73. Milling assets: Without a competitive market for milling capital there can be no assurance that mill management is efficient, that location, size and capacity utilization of mills is optimal, or that financing and the rate of adoption of new technology is appropriate. Government ownership and centralized and bureaucratic decision-making processes stemming from it, lock entrepreneurship out of the public milling sector and restrict the adoption of modern management ideas and systems.

74. Centralized controls take away the flexibility needed by individual mill managers to solve problems quickly. Moreover, government influence places political constraints on the profit function of mills. One outcome of such influence has been chronic overmanning in mills and generous wage settlements. Anecdotal evidence of the seriousness of this problem is demonstrated through the comparison of the labor productivity of a Mexican mill with a neighboring mill in Belize.

75. The Alvaro Obregon mill on Mexico's southern border with Belize produces 22 tons of sugar per day per worker. By comparison, the Tower Hill sugar mill in Belize just over the Mexican border achieves 36 tons per worker

per day (some 60% higher). The Mexican mill could have an advantage through economies of scale. It produces 10,000 tons of sugar daily, compared to 6,000 tons for the Tower Hill mill. Given that labor costs absorb around 40% of the milling margin, labor productivity is very important. A 60% increase in labor productivity in the Mexican mill would equate to 16% lower milling costs. In Colombia, mill labor productivity is double that in Mexico and so gains in excess of 60% may be realistic in the long term.

76. Until recently, the government of Mexico owned around 70% of the sugar mills. Although the operation of private mills is constrained by similar regulatory restrictions to the public mills, the cost of production in private mills is less than for public mills. In 1983, public sector costs were 17% higher on average. In a move to reduce the high costs arising from government ownership, the government has been selling mills. To date, 19 mills (nearly 40% of the government mills) have been sold.

77. Although the privatization of mills may allow for some increase in efficiency, remaining regulatory controls will continue to restrict the efficiency of mills. Mills remain vulnerable to a cost-price squeeze due to the discordant fashion in which cane prices, mill door sugar prices and consumer prices are set. Until prices are determined in ways that reflect the complex trade-offs that exist between the cane-growing and milling sectors, opportunities for private mills to enhance industry efficiency will be limited.

78. Further, the generous wage settlements and other work conditions granted mill workers may not be changed quickly. Mill workers are well

organized and have a national labor contract which to some extent protects their terms and conditions. However, privatization has broken the nexus which helped unite mill workers during the seventies and most of the eighties. Collective bargaining with a diverse range of mill owners may not be achieved as easily as in the past when the government owned 70% of the mills. As a result, future wage settlements may tend to be more conservative than in the past. Nonetheless, the union power of the mill workers may allow them to resist moves to improve labor productivity.

79. Consumer price discrimination: Until recently, different prices were charged by AZUCAR to different consumers of sugar. For instance, higher prices were charged to foreign-owned soft drink manufacturers than to domestically-owned companies. While such arrangements have the potential to create distortions in the pattern of consumption, demand is typically highly price inelastic. So the distortions are likely to be minor. Perhaps, more importantly, differential pricing creates an incentive for black marketeering. The administrative and enforcement costs of effectively policing such price differentials would be high. Without strict enforcement, and to the extent that black marketeering occurs, resources would be wasted in the unnecessary double handling of sugar.

80. Pan-Mexican pricing: The fixing of sugar prices at the same level at all locations throughout Mexico means that transport, handling and storage costs are unlikely to be minimized. For instance, pan-Mexican pricing does not provide incentives for mills located close to export ports to specialize in the production of export grade sugar (usually raw) or for others close to major population centers to specialize in the production of different (usually

more refined) grades of sugar. Further, the specification of prices and quotas for three grades of sugar restricts the range of sugar available and limits opportunities for vertical integration and specialization by mills.

81. Monopoly acquisition and marketing: The absence of competition in marketing means that the marketing agent, AZUCAR, is under little pressure to contain costs. Moreover, subsidization of AZUCAR's financial losses by the government virtually absolves the marketing agent of responsibility for the costs of its activities. In 1989, the subsidy amounted to around US$350 million. Such protection inhibits the development of alternative and innovative marketing approaches.

82. The need for a monopoly marketing agent has been argued on the grounds that it facilitates the making and upholding of government-to-government contracts, to coordinate storage and shipping, to prevent black marketeering arising from differential pricing, and to economize on commercial, technical and information-gathering efforts. However, the need to have a monopoly agent to achieve such objectives is not obvious. Mexico holds only one small export contract with another government--the United States for 10,000 tons. Quotas could be auctioned off to supply this premium market. Further, monopoly marketing arrangements by themselves will not prevent black marketeering and there is no apparent reason why a public single seller (restricted in any case to marketing the Mexican crop only) should have an advantage over private traders in achieving commercial, technical and information economies or in coordinating marketing flows.

Appendix 2

MODEL SPECIFICATION, ESTIMATION AND LIMITATIONS

83. The model is an annual dynamic model of production, consumption, stock demand, and trade. The model is designed to be linked to the nine-sector model of Wong, Sturgiss and Borrell (1989). The-rest-of-world sector of Wong, Sturgiss and Borrell (1989) has been re-estimated with Mexico excluded from the sector.

The Model

- production:

$$Y = M1 + M2*CP + M3*CP + M4*CP + M5*CP + M6*CP + M7*CP + M8*CP + M9*T + M10*D + e \quad (1)$$

$$A = M11 + M12*CP + M13*GM + M14*OL + M15*T + e \quad (2)$$

$$R = K1 \quad (3)$$

$$Q = Y*A*R \quad (4)$$

- consumption:

$$C = M16 + M17*Y + M18*SP + e \quad (5)$$

- stock demand:

$$S = M19*Q \quad (6)$$

- cane pricing:

$$CP = K2 \text{ or } WP \quad (7)$$

- sugar price (consumers):

$$SP = K3 \text{ or } WP+K4 \quad (8)$$

- market clearing:

$$S + Q = C + S$$

where Q is sugar production; Y is yield of cane per hectare; A is area harvested in thousands of hectares; R is the sugar extracted from cane as a proportion of cane; C is per person sugar consumption; S is end-of-year sugar stocks; CP is the real cane price (1980 pesos/ton); D is a dummy representing the effects of weather on production; Y is per person disposable income; SP is the price of sugar (1970 pesos/kg); WP is the world price of sugar (1984 ¢/lb); GM is the number of mills owned by the government; T is a square root trend; OL is the international price of oil (1984 $/barrel); e is the residual and t denotes the year; M denotes parameters; and K denotes constants.

Production

84. Because the government virtually guarantees the supply of milling services to growers, all cane grown is milled. Production therefore responds to the price that growers receive rather than that received by millers. Although several alternative crops could be grown in the place of cane, cane is a ratooning monocultural crop in Mexico being grown for about seven or eight years before replanting. In addition, under collectively negotiated contracts between growers and their mill, the freedom of individual growers to change to alternative crops is restricted--at least in the short run. And, as stated earlier, health benefits attaching to the growing of cane may reduce growers' incentives to switch crops. No statistically significant relationship could be found between sugar production and the current or lagged maize, bean or tomato prices.

85. The yields of cane over the life of the cane plant follow a distinct pattern. The first crop (the "plant" crop) generally provides the highest

yield. In subsequent years, yields decline; although the rate of decline lessens progressively. It therefore might be expected that in response to a rise in the cane price, new plantings and increased replanting of old cane might initially raise yields above average. However, as the cane ages, yields eventually decline and fall below average. To capture this behavior in the production equation, an Almon polynomial lag of degree 3 was fitted. In line with the current long ratooning pattern, six lags and the current price were specified in the equation. Responses to the current price and, to a large extent, to the one-year lagged price occur not through new plantings but through increased application of variable inputs.

86. Adverse weather is a major cause of yield declines. Adverse weather conditions can affect several countries in any year, since conditions in different regions are often interrelated. (For example, the well-documented El Nino effect links droughts in Asia and Australia with floods in the Caribbean and South America.) For this reason, the weather dummy used in the Cuban and rest-of-the-world sectors of the model of Wong et al. was also used as a proxy for weather conditions in Mexico. Note that, in this case, the dummy does not simply remove outliers in estimation (although it may do so), since the choice of years is not determined from the Mexican production data.

87. Improvements in technology typically lead to increases in crop yields through time. A square root trend was fitted to take account of the expected declining rate of technological and yield improvements.

88. Increases in area cannot be made instantaneously. If price rises are announced prior to planting, a lag of approximately two years occurs before

increased plantings are harvested. Planning and land preparation may involve lags of several months. Once planted, the plant crop is left to grow approximately 18 months before harvesting (subsequent ratoon crops are harvested every 12 months). For reasons explained earlier, producers currently have little incentive to anticipate real changes in domestic cane price.

89. As argued in Section III, government ownership of mills is likely to have imposed severe cost burdens on the industry, causing a negative influence on production.

90. The oil price boom of the seventies and early eighties impacted negatively on sugar areas. It strongly fueled inflation which, given the lags and arbitrariness of adjustment to fixed prices, caused considerable uncertainty about the movements in real prices and mill margins. Secondly, flush with oil revenues the urgency for the government to maintain rural-based exports such as sugar was lessened and the rate of investment and maintenance of government-owned mills lessened. The political power of the rural groups may also have lessened causing investment in new irrigation schemes and other rural infrastructure to decline.

91. Through time, development of infrastructure and technological improvements allow for the opening of new land for cropping. Because there must be some limit to the amount of land that can be ultimately developed, a square root trend was used to account for this influence. A study conducted in the seventies concluded there were considerable areas of lands suitable for cane production in Mexico. An area approximately three times the current area was identified as suitable.

92. No meaningful behavioral relationship describing movements in the amount of sugar extracted from cane could be econometrically estimated. The sugar content of cane extracted was, therefore, set at the average prevailing over the estimation period, 1967 to 1987.

93. The estimated parameters of the model are given in Table A1. The elasticity of supply response to the current price is estimated at around 0.06. The combined elasticity for the current and following year is 0.16. Combining the current and two following years gives an elasticity of around 0.35. The long-run price elasticity (after allowing for all lags) is estimated at 0.63.

Consumption

94. Per person consumption of sugar is modeled as a function of the regulated current price of sugar and per person disposable income. Alternative sweeteners are not major substitutes for sugar in Mexico. The price elasticity of demand was estimated at -0.004. The income elasticity was estimated at 0.5.

Stock Demand

95. Several different specifications of stock demand were estimated. In simulation, however, they did not perform well so stocks were set as a proportion of production. The proportion was set equal to the average

proportion over the estimation period. Pipeline stocks and those held for transactions purposes will generally grow in line with the volume of sugar handled. Production is a suitable indicator of such requirements and is included as an explanatory variable for this reason. It is also included to help represent a short-run stock adjustment process whereby stocks are used to smooth trade flows in the face of production variability.

Cane Prices

96. No significant behaviorial relationships describing movements in the cane or consumer sugar prices could be econometrically estimated. Prices were, therefore, set at the average prevailing over the estimation period, 1967 to 1987.

Data

97. Production data was taken from AZUCAR (1988). Consumption data and stock data were taken from the International Sugar Organization's Yearbook (1987 and earlier editions). Cane prices, inflation indices and real effective exchange rates were obtained from the Reserve Bank of Mexico. Sugar prices and per capita incomes were taken from Chavez (1989).

Table A2.1: Parameter Estimates of the Mexican Sugar Model

Equation	Coefficient	Estimate	t Statistics	$\bar{R}^2$	DW
1	M1	19.0412	0.795798		
	M2	0.0103	1.02866		
	M3	0.028564	3.46394		
	M4	0.029361	2.85887		
	M5	0.019224	1.78429		
	M6	0.004687	0.417435		
	M7	-0.00771	-0.06792		
	M8	-0.01145	-1.32601		
	M9	3.97951	3.55797		
	M10	-3.19686	-2.58354	0.692	2.3
	SUMLAG	0.07296			
2	M11	-370.729	-3.50727		
	M12	0.17568	1.64108		
	M13	-3.09742	-2.49055		
	M14	-1.53628	-1.66036		
	M15	166.335	6.98492	0.916	1.6
5	M16	21.784	7.97602		
	M17	0.002095	8.20093		
	M18	-1.19066	-2.58433	0.833	1.89
6	M19	0.22			
3	K1	8.8			
7	K2	393			
8	K3	1.43			
9	K4	1.7			

Note: K2 and K3 from 1989 onwards.

Model Limitations

98. There are limitations relating to the model, data, and assumptions of the analysis. Chief among these is the assumption that shifts in the supply

curve will be parallel. Parallel shifts assume equal reductions in marginal costs of all units of production. The method of modeling used can give no assurance that this is indeed the case. However, in the case of the measured average increase in yields arising from reducing the number of ratoon crops before replanting, parallel shifts seem reasonable. In the case of the effects of reduced government ownership of mills, it is less clear that supply shifts would be parallel. Non-parallel shifts would provide lesser gains than those estimated here. Nevertheless, only two of several potential supply curve shifts are considered in the analysis. Other shifts in the supply curve, made possible by a liberalizing of trade and production, may provide large additional gains. For instance, no attempt has been made to quantify the additional costs imposed on the industry due to pricing arrangements which take away producers' incentives to anticipate the world market and adjust production accordingly.

99. It is not unreasonable to assume that the current lagged response to changes in domestically-set prices would lessen if producers faced the world price. That no strong econometric evidence could be found to establish a behavioral relationship describing government (real) price setting, suggests movements in domestic prices are largely unpredictable. Furthermore, prices are relatively stable. Therefore, producers have little incentive to anticipate prices at present. By contrast, the econometric results of the world model used in this study suggest there are some elements of predictability about the world market price, and it is a highly variable market.

100. In a free market, producers would have large incentives to anticipate the world market and exploit the cyclical nature of the prices by adjusting their ratooning pattern accordingly. Production increases better synchronized with price rises could be expected over and above the present simulation results. Other shifts in the supply curve may also occur. With less intervention, better cane-pricing arrangements which provide incentives to grow and deliver cane of higher quality may emerge. Increases in the sugar content and extraction of sugar, industry-wide, may provide further substantial gains.

101. In sum, while there may be limitations relating to the modeling approach used here, the results at very least suggest that the scale of problems in the sugar industry is, in all probability, very large.

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS581	How Successful is World Bank Lending for Structural Adjustment?	Patrick Conway	January 1991	S. Fallon 37947
WPS582	Adjustment Programs and Bank Support: Rationale and Main Results	Vittorio Corbo Stanley Fischer	January 1991	L. Oropesa 39075
WPS583	World Bank Lending for Education Research, 1982-89	Marlaine E. Lockheed Alastair G. Rodd	January 1991	C. Cristobal 33640
WPS584	Whither Hungary and the European Communities?	Alfred Tovias Sam Laird	January 1991	G. Ilogon 33732
WPS585	Financial Innovation and Money Demand: Theory and Empirical Implementation	Patricio Arrau Jose de Gregorio	January 1991	S. King-Watson 31047
WPS586	The Challenging Arithmetic of Poverty in Bangladesh	Martin Ravallion	February 1991	WDR Office 31393
WPS587	Quantifying the Magnitude and Severity of Absolute Poverty in the Developing World in the Mid-1980s	Martin Ravallion Gaurav Datt Dominique van de Walle Elaine Chan	February 1991	WDR Office 31393
WPS588	Obstacles to Developing Small and Medium-Sized Enterprises: An Empirical Assessment	Brian Levy	February 1991	E. Madrona 37496
WPS589	To Prescribe or Not to Prescribe: On the Regulation of Pharmaceuticals in Developing Countries	Jeffrey S. Hammer	February 1991	O. Nadora S6-065
WPS590	The Domestic Financial Market and the Trade Liberalization Outcome: The Evidence from Sri Lanka	Premachandra Athukorala Sarath Rajapatirana	February 1991	M. Kienzle 30733
WPS591	Global Indicators of Nutritional Risk	Rae Galloway	February 1991	O. Nadora 31091
WPS592	Official Credits to Developing Countries: Implicit Transfers to the Banks	Asli Demirgüç-Kunt Harry Huizinga	February 1991	S. King-Watson 33730
WPS593	Risk Management in Sub-Saharan Africa	Stijn Claessens Ying Qian	February 1991	J. Carroll 33715
WPS594	Size Rationalization and Trade Exposure in Developing Countries	Mark J. Roberts James R. Tybout	February 1991	S. Fallon 37947

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS595	Hungary: Financial Sector Reform in a Socialist Economy	Mario I. Blejer Silvia B. Sagari	February 1991	Z. Sequis 37665
WPS596	The Mexican Sugar Industry: Problems and Prospects	Brent Borrell	February 1991	P. Kokila 33716